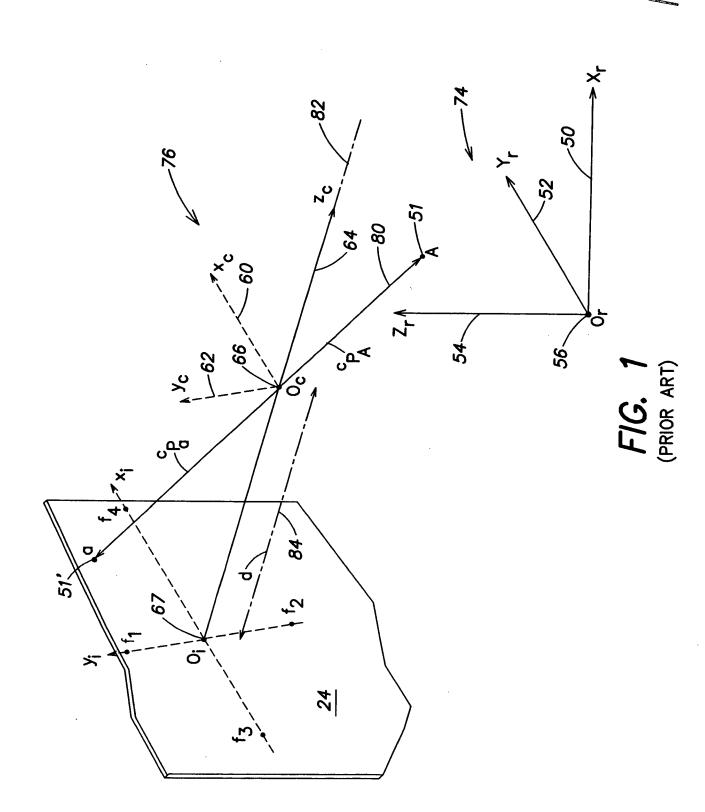
.]

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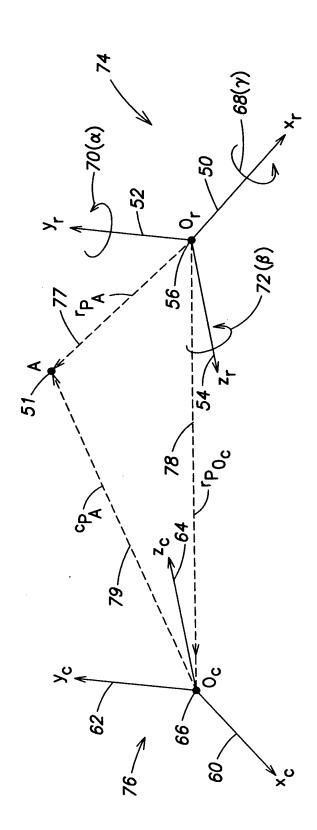
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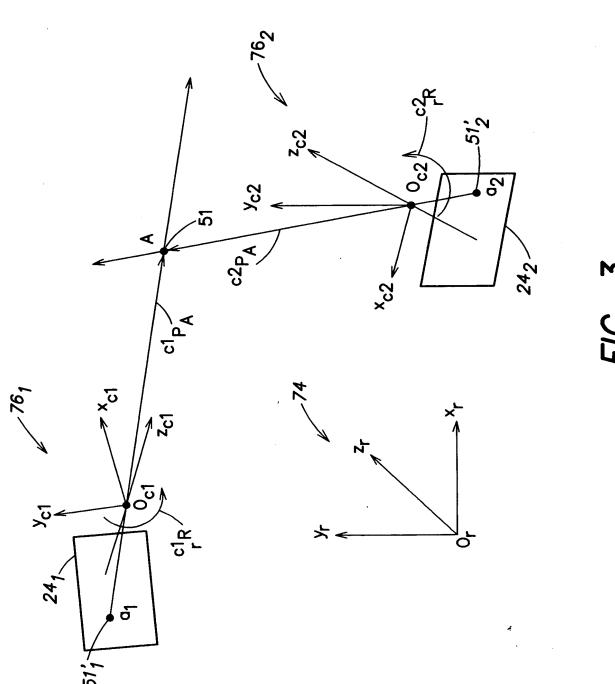


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ORIENTATION AND DISTANCE 6/44 COPY OF PAPERS ORIGINALLY FILED 0 * -20A 56 26A F1G. 6 99 82 120B IMAGE METROLOGY PROCESSOR * * * * 0 26B 28B 20C

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ORIENTATION AND DISTANCE COPY OF PAPERS ORIGINALLY FILED 7/44 WORKSTATION PROCESSOR 120B CLIENT .120C -28B 26B OTHER WORKSTATIONS FIG. 7 40A CLIENT WORKSTATION PROCESSOR **SCANNER** -36A 40B METROLOGY SERVER 26B IMAGE 28B ቀ የ 38/ 40A 20C-

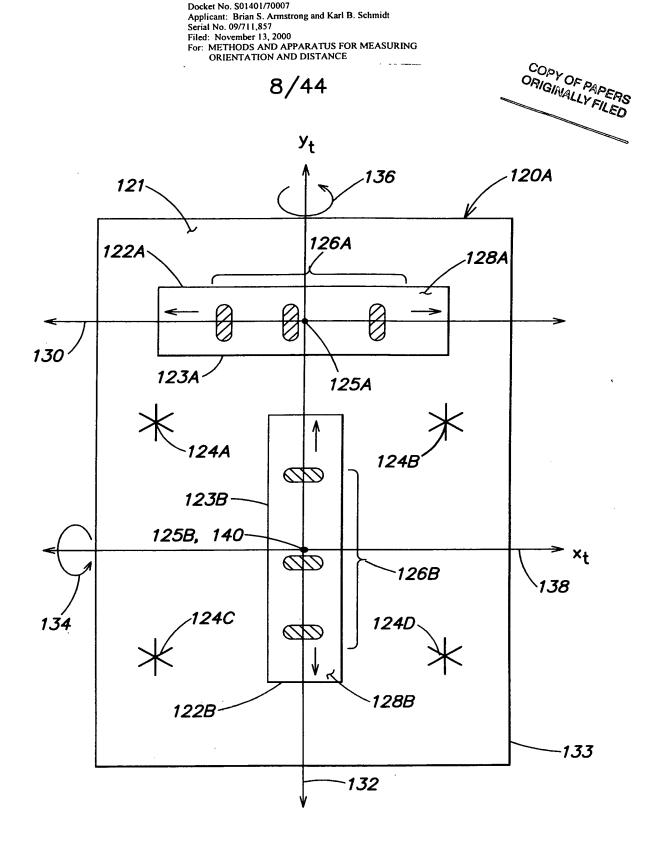
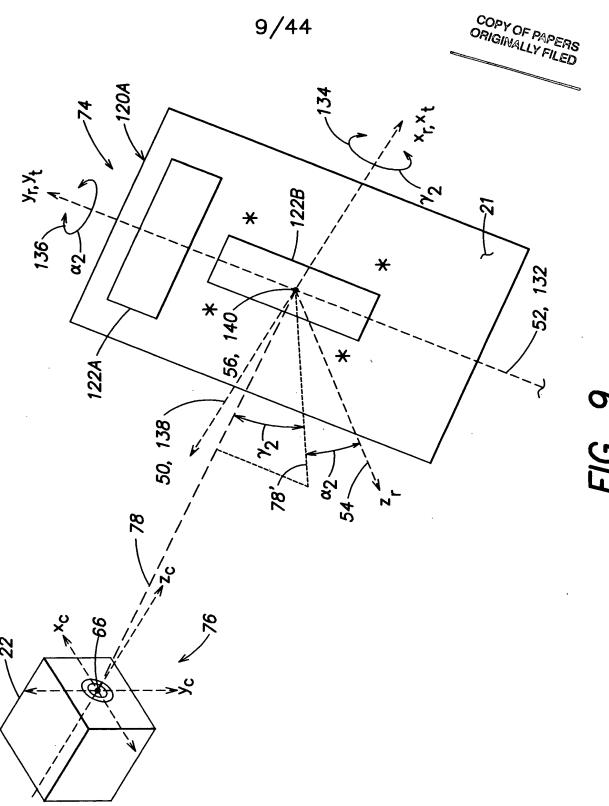


FIG. 8



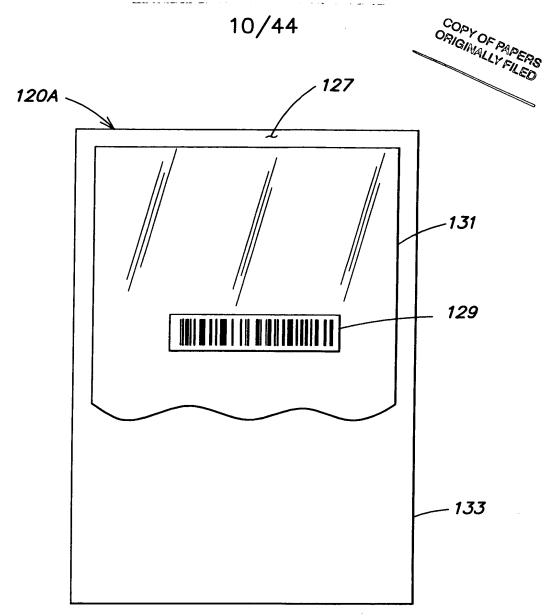


FIG. 10A

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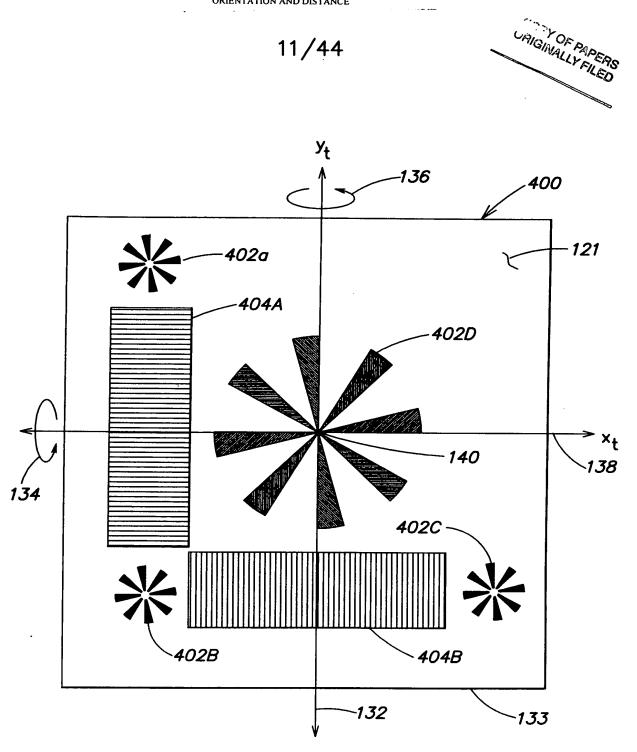


FIG. 10B

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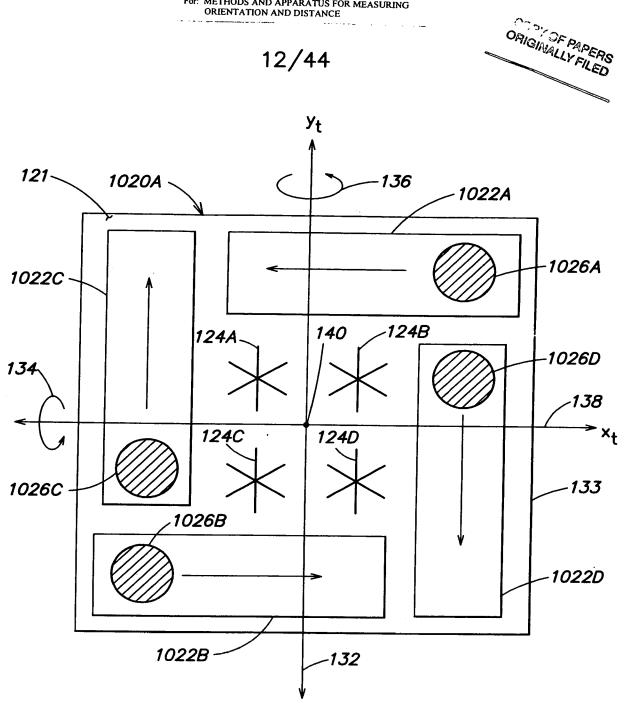


FIG. 10C

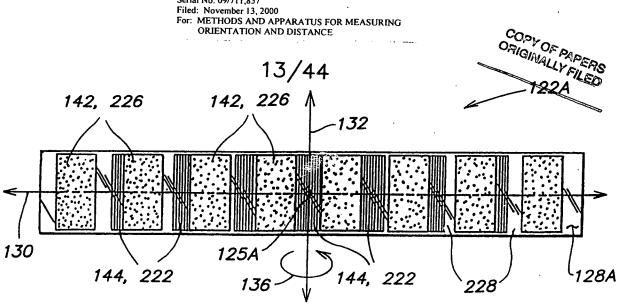


FIG. 11A

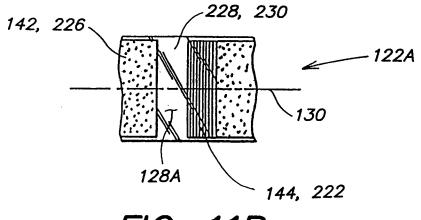


FIG. 11B

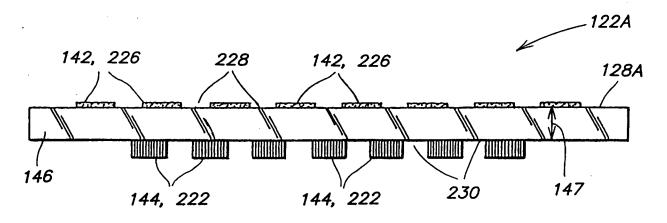


FIG. 11C

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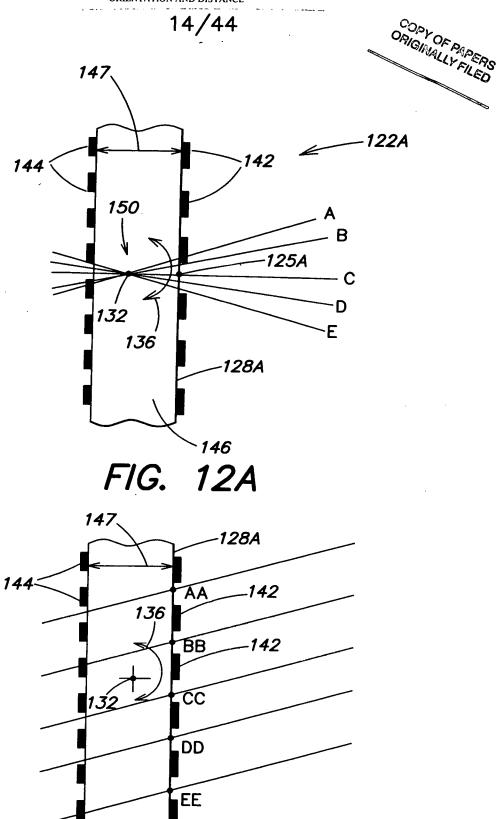
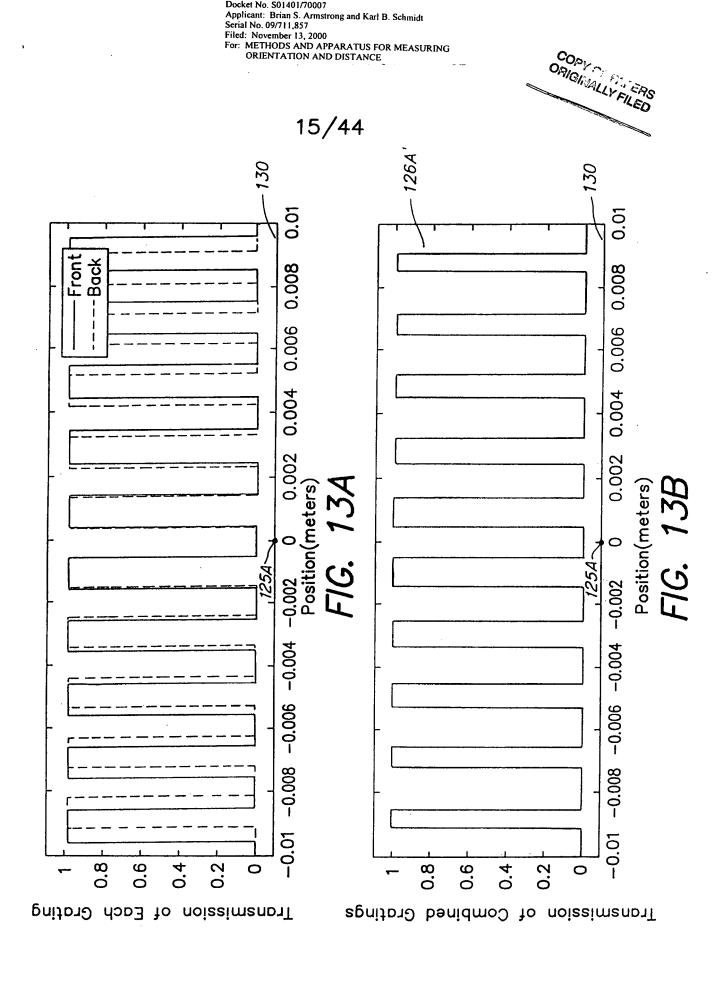
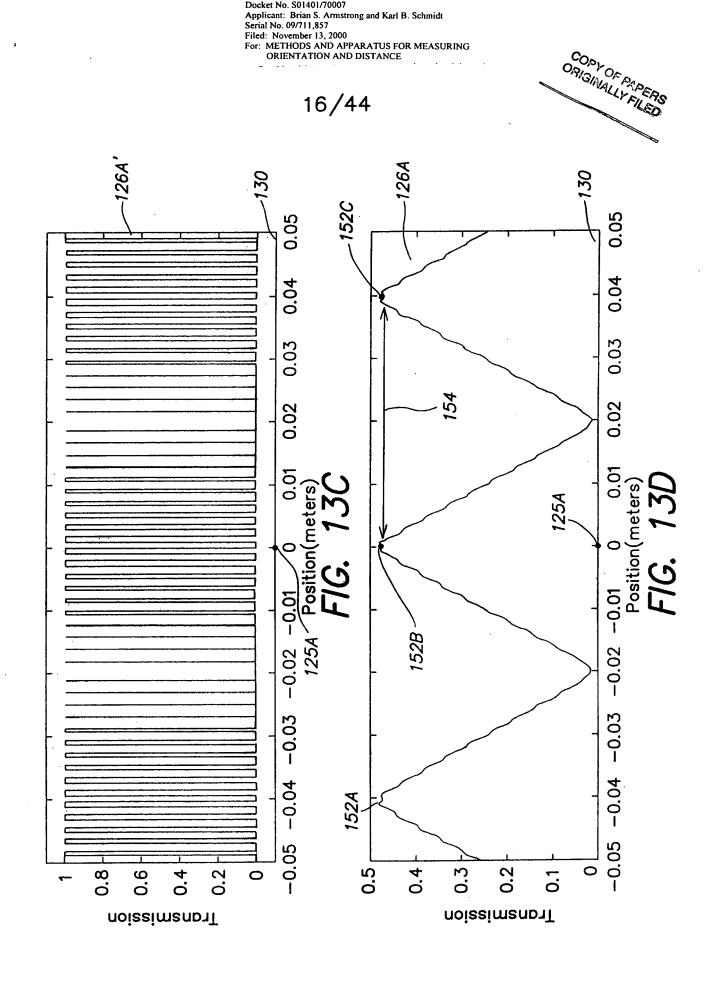


FIG. 12B





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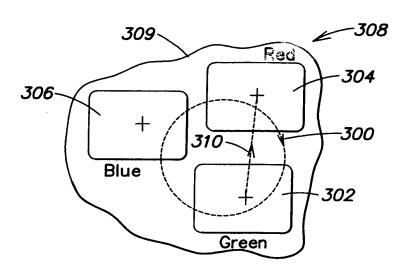


FIG. 14

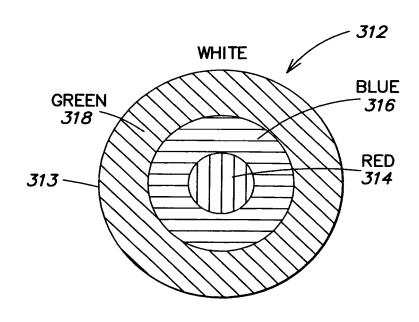


FIG. 15

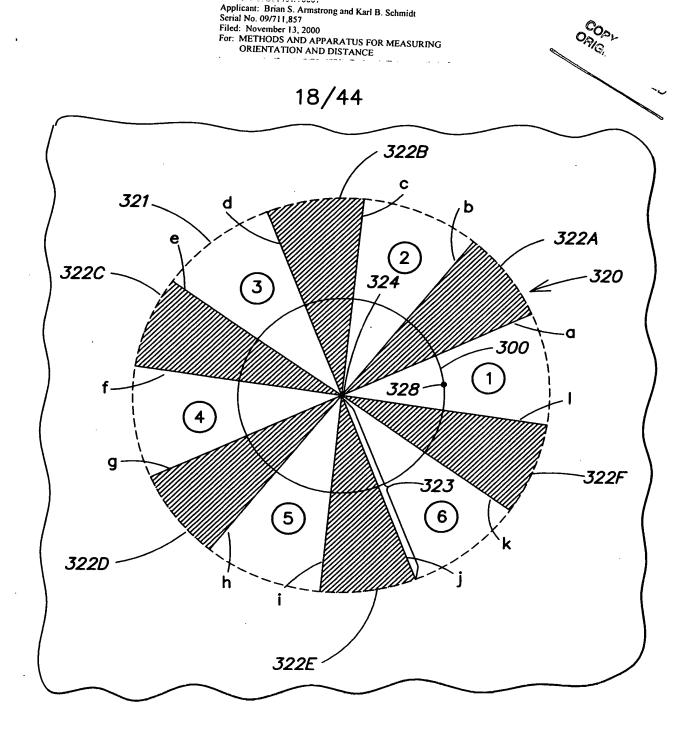


FIG. 16A

19/44 150 334 100 Filtered Luminance 50 0 -50 -100 -15050 150 250 300 350 100 200 400

FIG. 16B

Phi (deg) Angle Around Circle

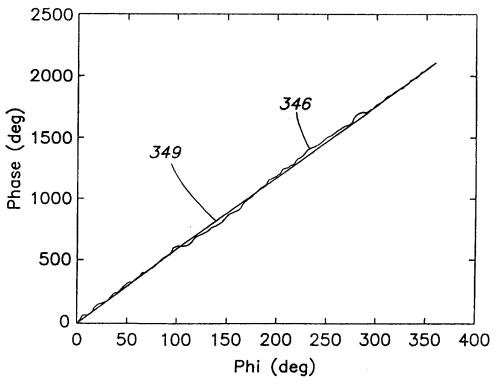


FIG. 16C



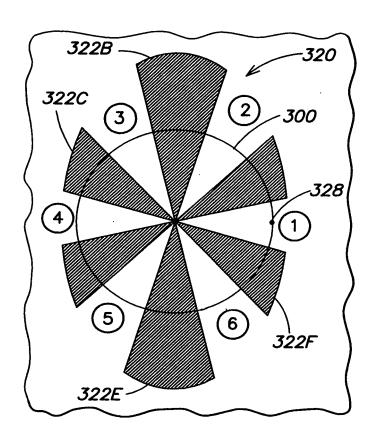


FIG. 17A

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FIG. 17B

Phi (deg) Angle Around Circle

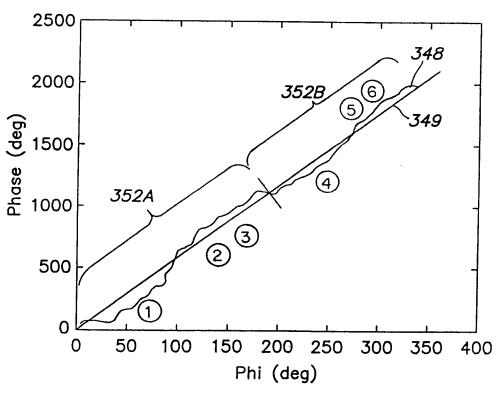


FIG. 17C

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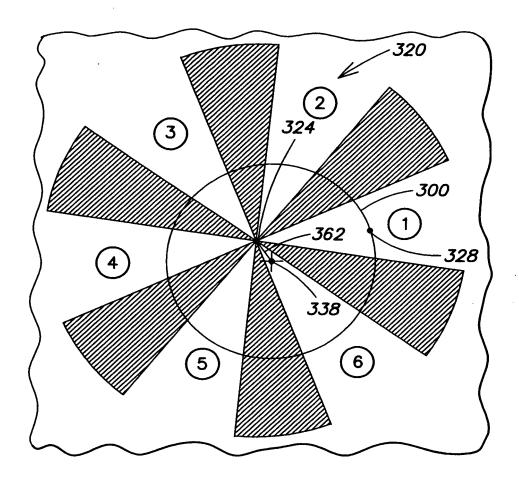


FIG. 18A

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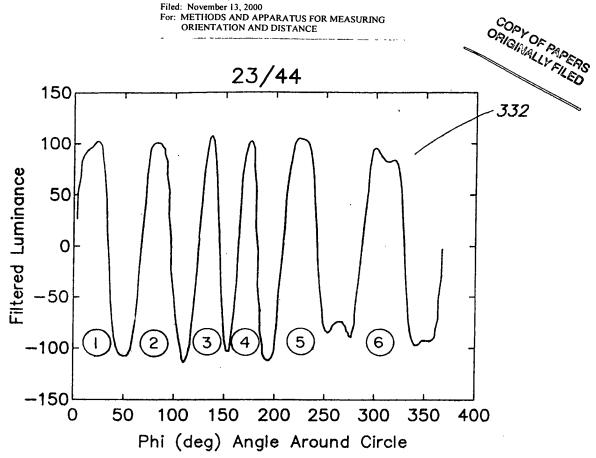


FIG. 18B

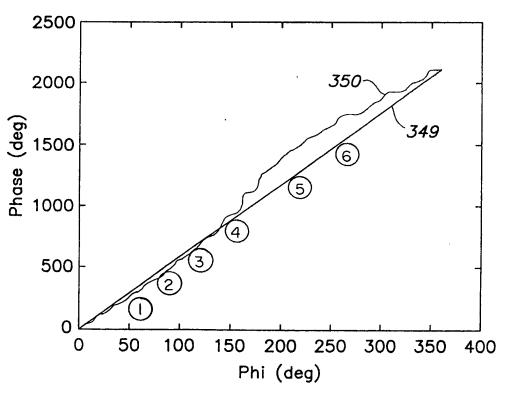
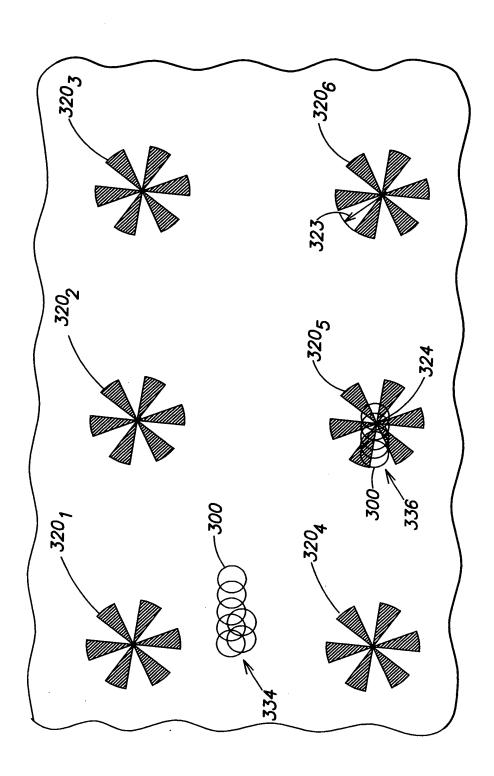


FIG. 18C

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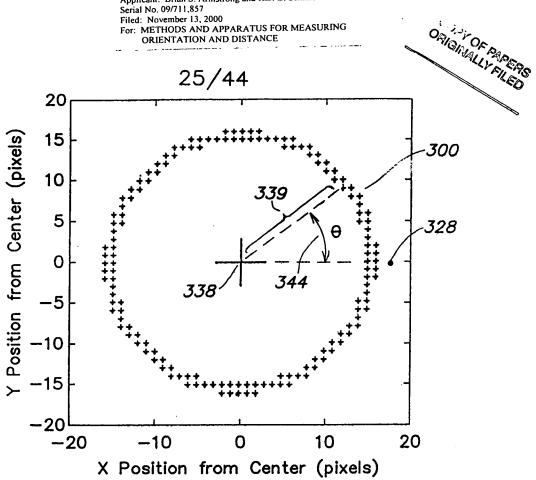


FIG. 20

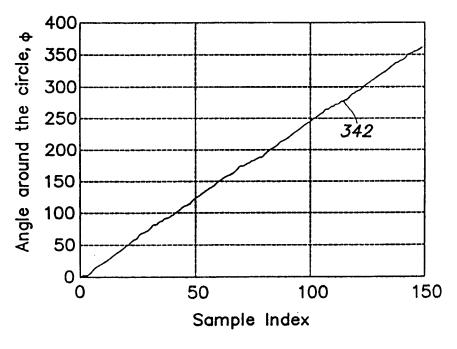


FIG. 21

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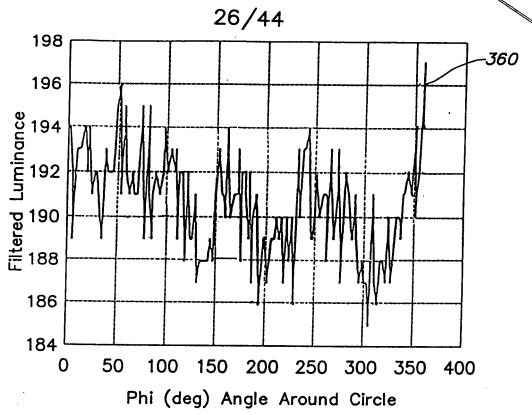


FIG. 22A

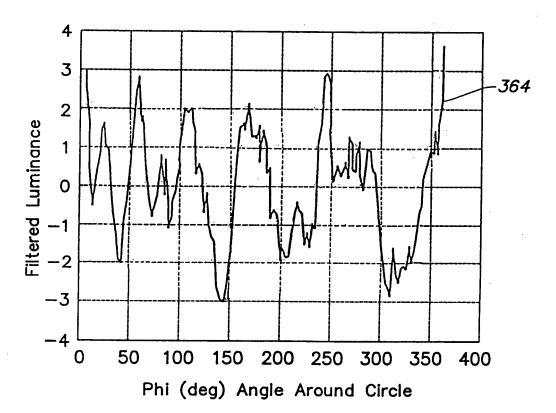


FIG. 22B

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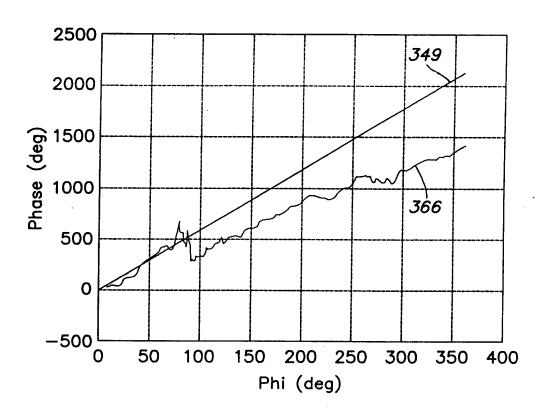
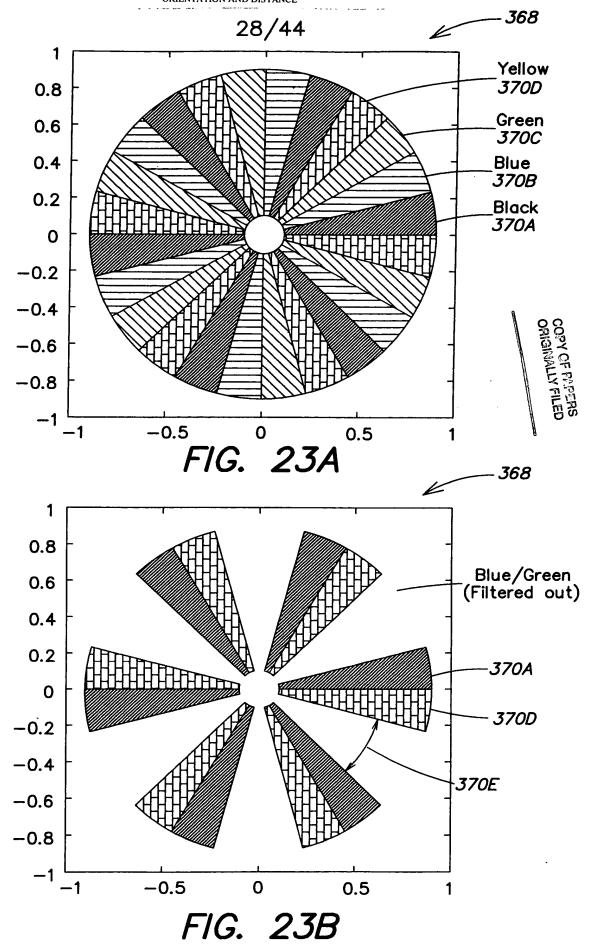


FIG. 22C

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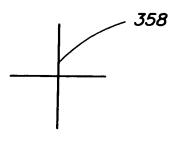


FIG. 24A

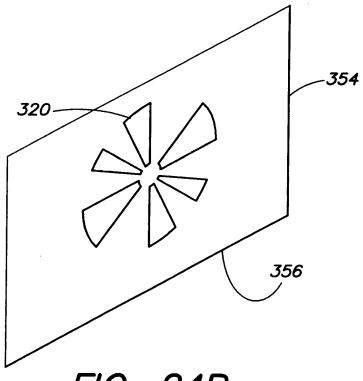


FIG. 24B

Serial No. 09/711,857 Copy of Papers Filed: November 13, 2000 ORIGINALLYFILED For: METHODS AND APPARATUS FOR MEASURING ORIENTATION AND DISTANCE 30/44 START *502* Enter/Download to processor camera model (interior orientation, lens distortion) estimates or manufacturer data 504 Enter/Download to processor reference information associated with one or more reference targets/objects appearing in image *506* Obtain image of scene (including reference targets/objects) with camera, and download to processor 508 Scan image to automatically locate at least one fiducial mark (and hence locate reference target in image) - 510 Fit image of reference target to artwork model of target based on reference information, to locate ODRs in image 512 Analyze radiation patterns emanated by ODRs 514 Determine ODR rotation angles from analyzed ODR radiation patterns 516 Determine distance between camera and reference target (Zcam) from observed ODR radiation patterns, based on near field effect (optional) 518 Calcluate camera bearing angles from ODR rotation angles

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FIG. 25A

COPYOFPAPERS ORIGINALLY FILED Serial No. 09/711,857 Filed: November 13, 2000 For: METHODS AND APPARATUS FOR MEASURING ORIENTATION AND DISTANCE 31/44 Determine an initial estimate of camera exterior orientation based on calculated camera bearing angles, camera model estimates (interior orientation), and reference information associated with at least two fiducial marks (e.g., using a system of modified collinearity equations) 522 Refine estimates of camera calibration information (e.g., interior and exterior orientation, and lens distortion parameters) by least-squares iteration using one or more of initial estimation of exterior orientation, camera model estimates, reference information, and distance Zcam between camera and target, to obtain coordinate transformation from camera image plane to reference coordinate system for scene 524 Manually or automatically identify points/objects of interest in the scene from the image of the scene, for which position/size information is desired *526* No Do Points/Objects of interest lie in the reference target plane? Yes Enter/Download to processor relationship/transformation between reference plane and measurement plane in which points/objects of interest lie 530 Apply appropriate 528transformation to identified points/objects of interest to obtain actual position/size information in scene FIG. 25B **END**

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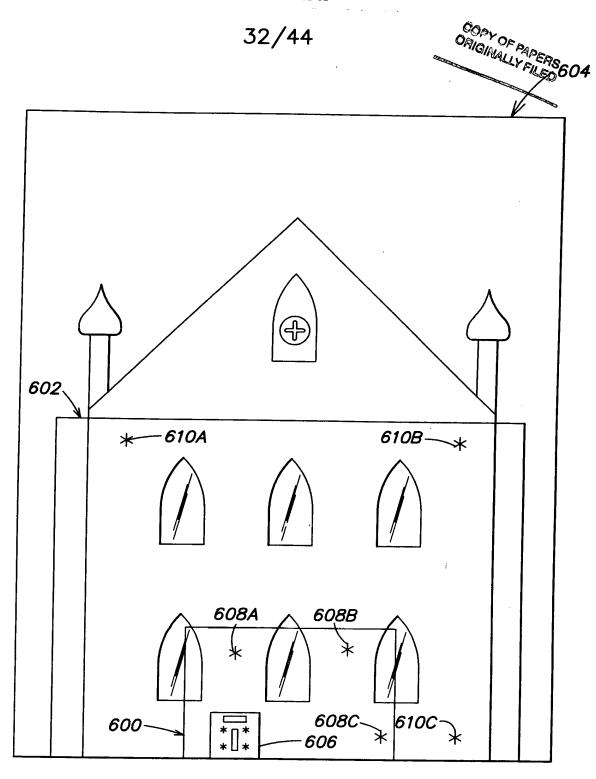
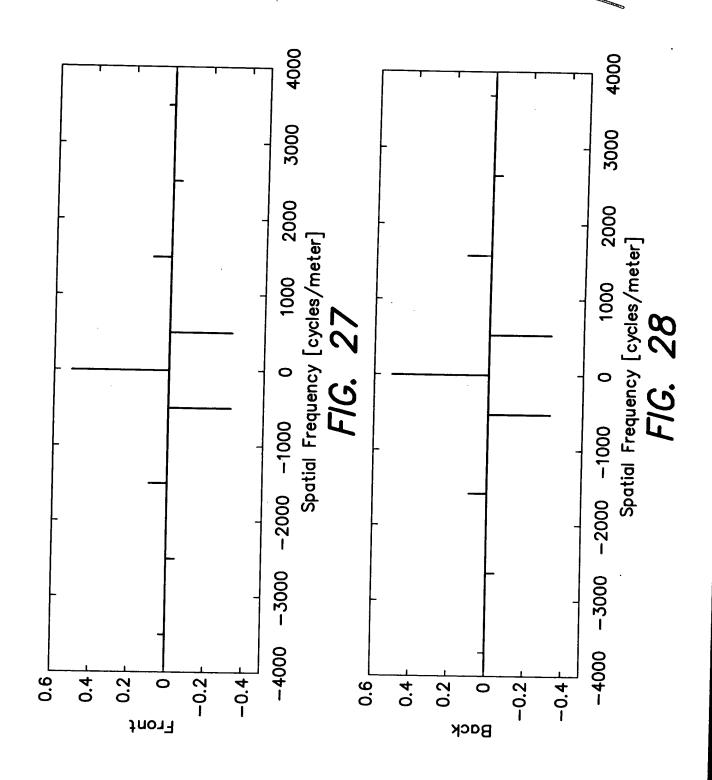


FIG. 26

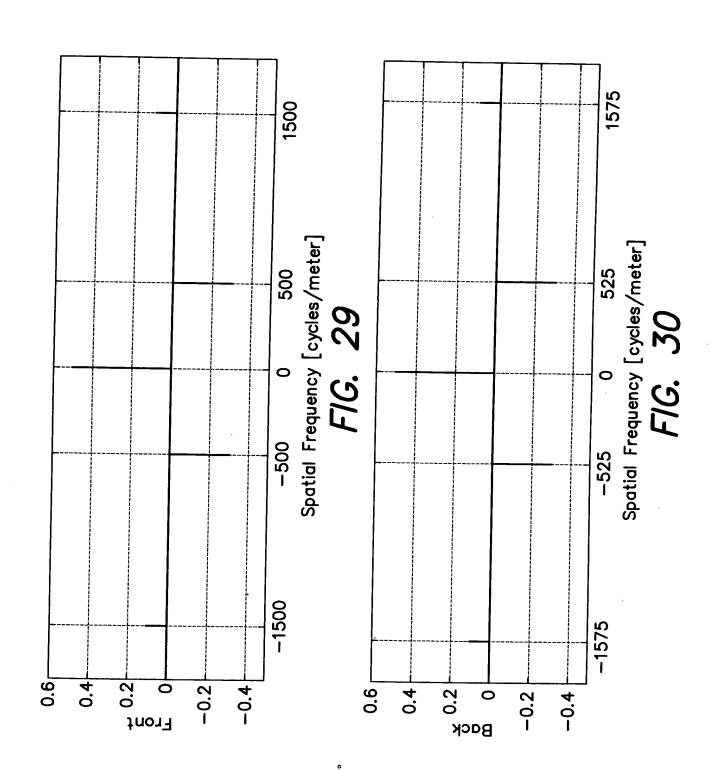
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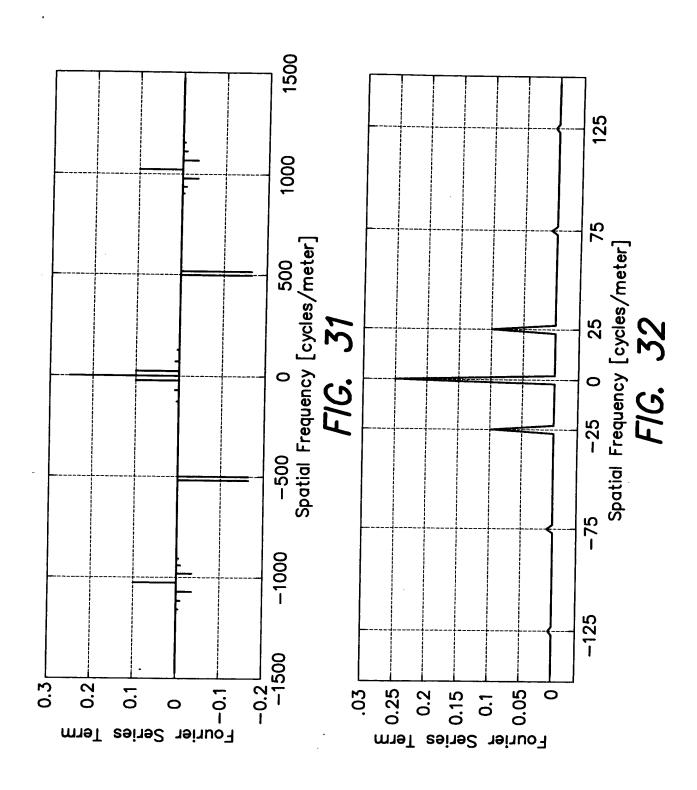


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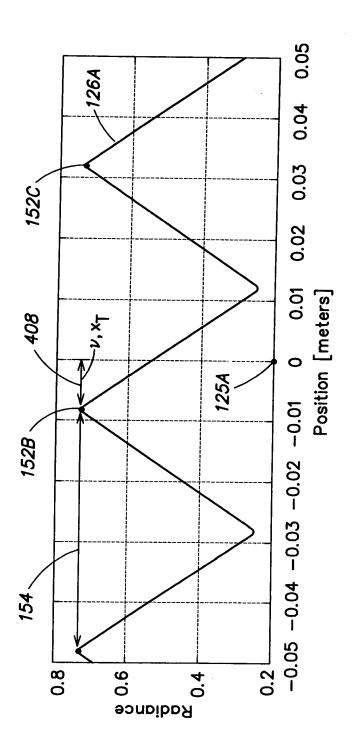


FIG. 33

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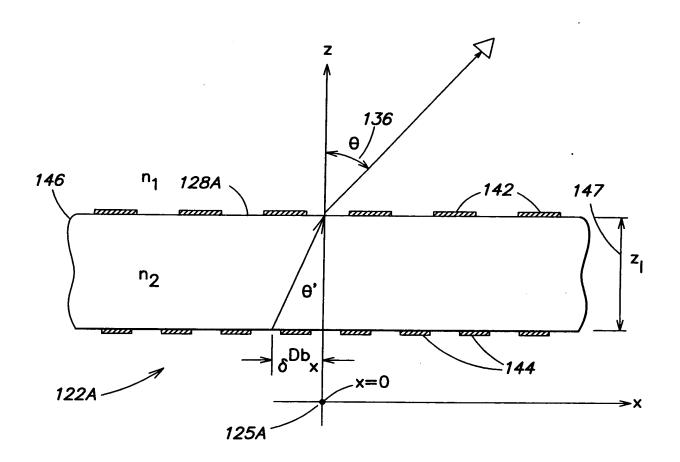


FIG. 34





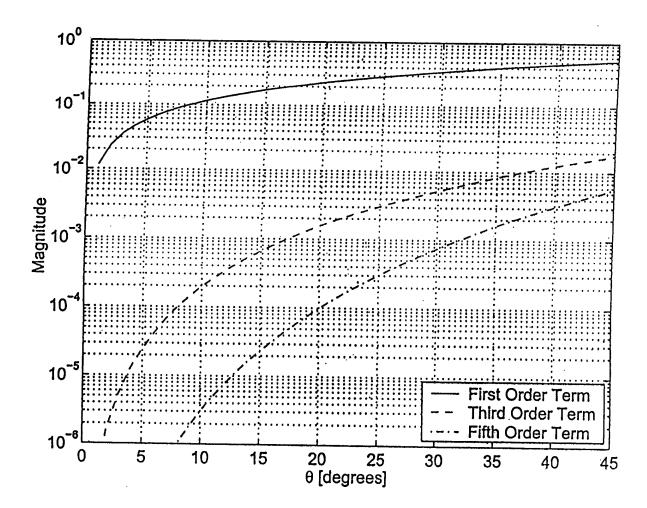


FIG. 35

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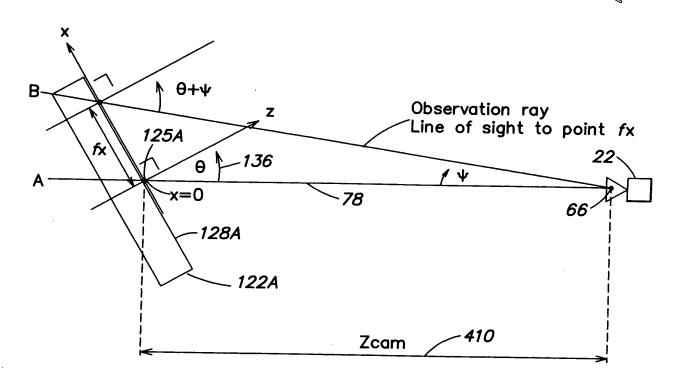


FIG. 36

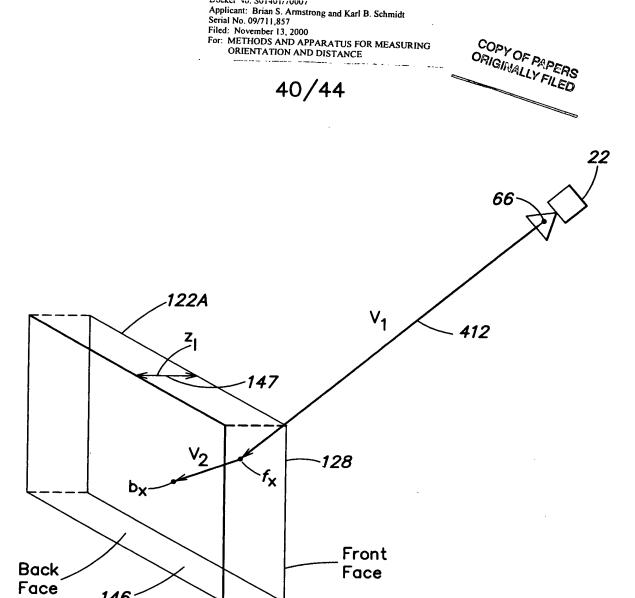


FIG. 37

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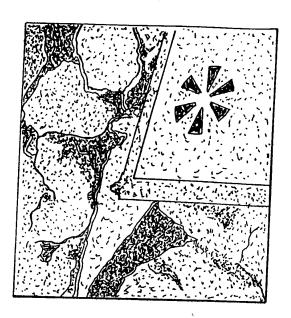


FIG. 38

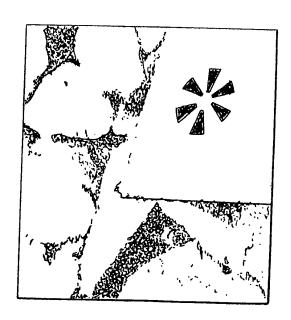


FIG. 39

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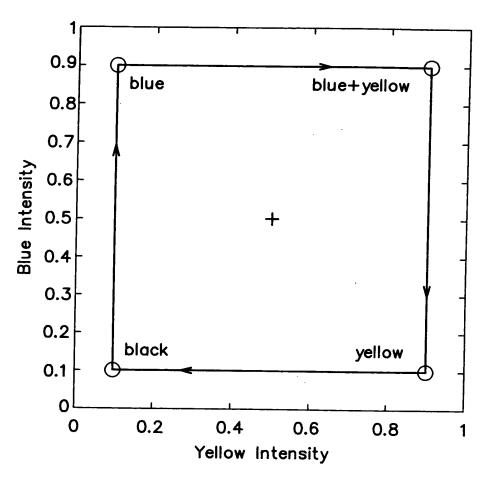


FIG. 40

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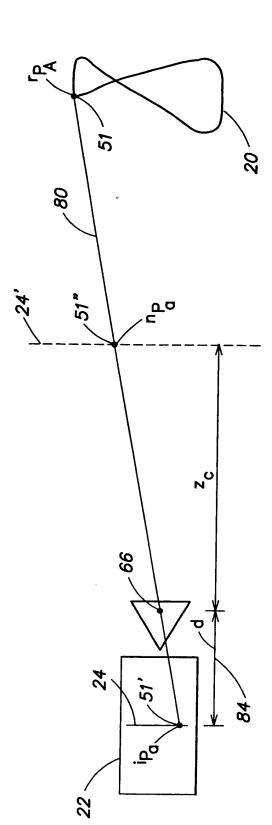


FIG. 41

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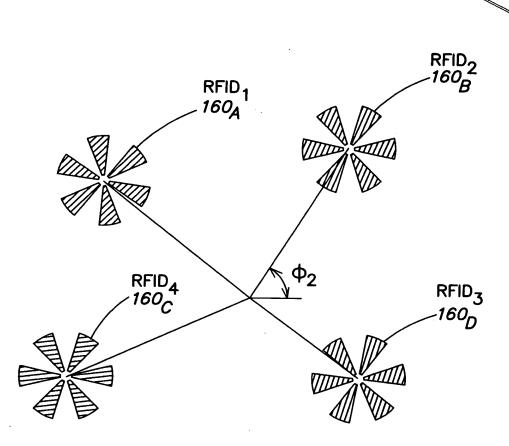


FIG. 42